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LIQUID CRYSTAL PANEL, AND METHOD AND MANUFACTURING APPARATUS FOR MANUFACTURING THE SAME

[Abstract]

PROBLEM TO BE SOLVED: To facilitate the ultraviolet curing of a sealing material in a color reflection type liquid crystal panel.

SOLUTION: The method for manufacturing a liquid crystal panel has a process in which a ultraviolet curing type sealing material 2-8 is formed for adhering two opposite substrates 2-1 and 2-3 and enclosing liquid crystal 2-6, a process in which two substrates are stuck after positioning the substrate opposed to the substrate on which the sealing material 2-8 is

formed, a process in which the stuck substrates are pressurized so as to obtain a prescribed gap, a process in which the part except sealed portions is shielded, a substrate temperature is controlled within the range of 40°C to 80°C, and the sealed portions are irradiated with a ultraviolet ray, and a process in which the substrate is cut by leaving a necessary terminal portion to create a liquid crystal cell.

[Claims]

[Claim 1] A method for manufacturing a liquid crystal panel in which an electrode of at least one substrate is formed of a shielding material and the other substrate has a color filter and a black matrix thereon, the method comprising: adhering two substrates to each other and forming an ultraviolet curing type sealing material for enclosing liquid crystal on one substrate; position-aligning the substrate opposed to the substrate on which the sealing material is formed and sticking the two substrates; pressurizing the stuck substrates to obtain a predetermined gap; shielding the part except sealed portions, controlling a temperature of the substrates within a temperature range of 40°C to 80°C, and irradiating the sealed portions with ultraviolet rays; and cutting the substrate by leaving a necessary terminal portion to create a liquid crystal cell.

[Claim 2] The method of claim 1, further comprising: dropping and supplying liquid crystal between the forming the sealing material and the sticking the two substrates to each other.

[Claim 3] The method of claim 1 or claim 2, wherein the ultraviolet curing sealing material is composed of metacrylic or acrylic resin, a composition of a photo-initiator is one of an acetophenone system, a benzoin system and a benzophenone system, the compounding ratio is within the range of 1wt% to 3wt%, and a thioxanthone system as a photo-initiator is compounded at the compounding ratio of the range of 1wt% to 3wt%.

[Claim 4] The method of claims 1 to 3, an effective wavelength range is from 310nm to 400nm, brightness in the wavelength range is below 10mw/ cm^2 to 30mw/ cm^2, and the integrated quantity of light is from 3,000 mJ/cm^2

to 10,000 mJ/ cm^2.

[Title of the Invention]

LIQUID CRYSTAL PANEL, AND METHOD AND MANUFACTURING APPARATUS FOR MANUFACTURING THE SAME

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a method for manufacturing a liquid crystal panel.

[0002]

[Description of the Prior Art] A method for manufacturing a liquid crystal panel is performed by injecting liquid crystal into a gap of two electrode substrates and sealing the liquid crystal. A heat curing type epoxy resin of 1 liquid type ("SUTORAKUTO bond XN-21-S" manufactured by the Mitsui Toatsu Chemicals industry and "world lock 780-B-B" manufactured by the Kyoritsu Chemical & Co., Ltd.) is well known as a sealing material used to enclose liquid crystal.

[0003] In the sealing material composed of this heat curing type epoxy resin, in a heat curing process performed after substrates are bonded, viscosity of the sealing material is lowered and therefore problems such as deterioration in precision of alignment of the substrates, disconnection of a seal line and a defective gap caused by seal looseness occur. In addition, as a mother substrate increases in size, heat curing facilities increase in size.

[0004] A method for adopting an ultraviolet curing type sealing material may be considered to solve the problems. In general, there are two kinds of the ultraviolet curing type sealing material: cationic polymerization and radical polymerization.

The former cationic polymerization is for curing epoxy resin, and the radical polymerization is for curing methacryl or acrylic resin. Here, though the epoxy resin which is the cationic polymerization has excellent adhesiveness and constitution, since a photo-initiator having high ionicity of a cation system is used, reliability with respect to liquid crystal is low. Accordingly, a problem may occur if the ultraviolet curing sealing material composed of the epoxy resin of the cationic polymerization is used. In an ultraviolet curing type epoxy resin, ultraviolet curing type methacryl and acrylic resin are a radical polymerization collection, a photo-initiator being used has low ionicity, and therefore it is possible to use the dropping method. Accordingly, in general, methacryl and acrylic resin of the radical collection are used as the ultraviolet curing type sealing material.

[0005] In the method for manufacturing a liquid crystal panel, performed is a process in which an alignment film formed of polyimide resin is formed on substrates having a pair of electrodes thereon, and alignment direction of liquid crystal is determined by rubbing the surface of the alignment film with a rubbing cloth. The ultraviolet curing type sealing material is formed on the substrates in which alignment process is performed to have a predetermined by screen printing or drawing the sealing material by a dispenser. Spacers for forming a gap between the substrates are disposed on one of the substrates. Beads formed of resin are typically used as the spacers. However, recently, a pillar formed of resin is formed on the substrate. The two substrates are position-aligned and stuck to each other, and then are pressurized to thereby obtain a prescribed gap. Thereafter, the part except sealed portions is shielded, and only the sealed portions are

radiated with an ultraviolet ray and the sealing material is cured.

By dividing and cutting unnecessary portions of the two substrates stuck to each other, a liquid crystal cell is created. In addition, a dropping method in which a liquid crystal material is dropped and supplied to a region enclosed by a sealing material before adhering the substrates to each other and the two substrates are position-aligned under decompression below 0.8 Torr is well known as the method for manufacturing a liquid crystal cell.

[0006]

[Problems to be Solved by the Invention]

When an ultraviolet curing type sealing material is used, an ultraviolet ray must be irradiated at sealed portions. Accordingly, in a substrate formed of transparent electrodes such as ITO and a substrate on which a color filter is formed, an electrode unit must be a panel having a seal formed on an outer edge portion of a black matrix.

Currently, since a liquid crystal panel can have a TFT thereon can be manufactured at a low cost, demand in a market increases. As the liquid crystal panel having a TFT thereon is variously used, an edge portion thereof is narrowed in general, demand for a color reflection type liquid crystal panel increases as a portable power saving liquid crystal panel even in STN. While the demand for such a liquid crystal panel increases, electrodes are formed of AL and completely shield an ultraviolet ray in a TFT and an STN color reflection type liquid crystal panel. In addition, as colorization is performed and the end portion is narrowed, a seal becomes formed on a black matrix of a color filter. In the liquid crystal panel having such a construction, it becomes very difficult to perform the ultraviolet

curing of the sealing material.

[0007] In this case, the sealing material should be cured by irradiating an ultraviolet ray onto sealed portions from the Al electrodes. Currently, the width of the Al electrode is about 50 to 100 micrometers, and space portions between electrodes are about 5 to 20 micrometers. According to this pattern, a condition for irradiating an ultraviolet ray and a sealing material are required to sufficiently perform polymerization of a sealing material even on shaded portions of lines.

[0008] The present invention relates to a method for manufacturing a liquid crystal panel using an ultraviolet curing type sealing material capable of controlling a sticking degree of substrates and improving productivity. An object of the present invention is to provide a method for manufacturing a liquid crystal panel capable of corresponding to a TFT liquid crystal panel whose edge portion is narrowed or a reflection type color STN.

[0009]

[Means for Solving the Problem]

The problem can be solved by controlling a substrate temperature when an ultraviolet ray is irradiated in an ultraviolet curing process of a sealing material especially in a method for manufacturing a liquid crystal panel of the present invention. At this time, the temperature of the substrates is appropriately selected from 40°C to 80°C. In general, the higher the temperature of the substrates is when irradiating an ultraviolet ray, the more polymerization of a seal is promoted. However, when a dropping method is used, if the temperature when the ultraviolet ray is irradiated is high, a seal composition flows out from the sealing material which is not sufficiently

cured to liquid crystal, thereby causing deterioration in a visual quality. In addition, a yield is deteriorated because of gap height or seal disconnection.

[0010] In this case, the problem can be solved by adopting a method for sufficiently curing a seal, by which the substrate temperature increases according to time or a stage is divided to two steps, UV irradiation is performed on a seal at a low temperature at the first stage, and the UV irradiation is performed at a high temperature at the second stage.

[0011] As the method for adjusting the temperature of the substrates during the UV irradiation, any methods for increasing the temperature of the mask substrate by using the hot plate, warm air circulation, and ultraviolet absorption may be adopted.

[0012] Next, in relation to the ultraviolet curing type sealing material used under such a condition, one of methacrylic and acrylic resin is used as a principal material. Preferably, the component in which oligomer of epoxy acrylate and monomer for viscosity control are appropriately compounded is used. In the principal material, a photo-initiator is appropriately compounded within the range of 1wt% to 3wt% in the main resin composition. In addition, a thioxanthone system as a photo-initiator is appropriately compounded within the range of 1wt% to 3wt%. At this time, one photo-initiator can be selected from photo-initiators of an acetophenone system, a benzoin system and a benzophenone system, and especially, the photo-initiator of the benzoin system is selected, preferably. In addition, preferably, the sealing material is obtained by appropriately compounding a filler material for viscosity control and a silane system coupling material for the improvement in adhesion with a substrate.

[0013] By the method for manufacturing a liquid crystal panel in accordance with the present invention, in a process of irradiating a UV ray onto an ultraviolet curing type methacrylic and acrylic sealing material, by controlling the substrate temperature during the UV irradiation, the ultraviolet curing of the sealing material is possible in the liquid crystal panel whose electrodes are formed of a material which can be shielded such as Al, that is, in a TFT liquid crystal panel whose edge portion is narrowed and a reflection type color STN panel. In addition, a liquid crystal panel can be manufactured without applying a big burden to panel design later.

[0014] Here, the substrate temperature during the UV irradiation with respect to the sealing material is arbitrarily selected within the range of 40°C to 80°C. In general, when only UV irradiation of the sealing material is performed, the higher the substrate temperature is set, the more the curing of the sealing material is promoted. However, when the dropping method is used, if the substrate temperature exceeds 80°C during the UV irradiation with respect to the sealing material, liquid crystal becomes more than a phase transition and becomes an isotropic phase, and the solubility of the sealing material composition becomes high. In addition, since the volume of the liquid crystal increases, the height of the sealing material changes. Accordingly, the substrate temperature is below 80°C, preferably.

[0015] In addition, since an ultraviolet ray used to cure a seal needs to shield a wavelength of 310nm or less in order to prevent damage to liquid crystal by the UV ray. Accordingly, as the UV ray used to cure the seal, a wavelength range is from 310nm to 400nm, brightness exceeds 10 mw/cm^2, and more than 3000 mJ/cm^2 is required as the integrated quantity of light.

When the integrated quantity of light achieves 3000 mJ/cm^2 by $30mw/cm^2$, that is, the heights brightness from the conditioned range, irradiation time becomes one hundred seconds. At this time, set keeping time of the substrate temperature is obtained by subtracting a time until the substrate is lifted up from the one hundred seconds. When the area of the substrate is about $640,000mm^2$ from $250,000mm^2$ and the thickness of the substrate is about 1mm to 0.5mm, since it takes only about ten to twenty seconds for the substrate temperature to reach 80°C by positioning two substrates one to another, the UV irradiation toward a predetermined temperature is sufficiently possible.

[0016] As so far described, a method for manufacturing a liquid crystal which can produce a liquid crystal panel having a high visual quality can be provided because alignment precision is high and the sufficient curing of the sealing material is possible even when the electrode unit is shielded by the ultraviolet curing method of the sealing material in accordance with the present invention.

[0017] [Embodiment of the Invention] In the method for manufacturing a liquid crystal panel in accordance with the present invention, a sealing material for enclosing liquid crystal and simultaneously adhering two substrates to each other is for the ultraviolet curing, and this sealing material is irradiated with an ultraviolet ray and simultaneously heated.

[0018] A composition of the ultraviolet curing type sealing material used herein will be described. An epoxy acrylate oligomer and a 3 functional acrylate monomer are used as a principal material, and talc and silica system impalpable powder and a silane coupling agent as a filler material,

and a benzoin system added by 1 to 3 wt% as a photo-initiator.

[0019] Although it is desirable that the substrate has a configuration that the area thereof is about 640,000mm^2 from 250,000mm^2 and the thickness thereof is about 1 to 0.5mm, in the present embodiment, the dimension of the substrate is 550mm x 670mm and the thickness of the substrate is 0.7mm.

[0020] Next, a method for irradiating a UV ray to cure the sealing material will be described with reference to the accompanying drawings.

[0021] Figure 1 is a schematic view illustrating a UV irradiation device used in the present invention, wherein a high-pressure mercury lamp is used as a lamp 1-1 and shielding is performed by inserting glass 1-2 for shielding a wavelength of 310nm or less. In addition, brightness is set to be 10 to 13 mw/cm^2 when a wavelength range of the lamp is in the range of 310nm to 400nm. In addition, irradiation time is ten minutes, that is, irradiation energy is from 6,000 to 7,800 mJcm^2. In order that the part except for sealed portions is not irradiated with a UV ray, a mask 1-3 is inserted between the lamp 1 and a substrate 1-4 such that clearance becomes 1mm. A material of the mask 1-3 being used is tempax glass, in which there is almost no brightness loss of UV portions. A hot plate 1 for controlling the temperature is installed under the substrate.

[0022] [embodiment] Hereinafter, a specific embodiment of the present invention and a compared example will be described with reference to the drawings.

[0023] Figure 2 illustrates a cross-sectional diagram of a liquid crystal panel. A multilayer Cr layer 2-2 is formed in a slit shape on an upper

substrate 2-1 which is irradiated with a UV ray. In addition, this multilayer Cr layer 2-2 is not formed on a lower substrate 2-3. As a pattern of this slit, a total of six types of patterns are provided: two types of 40 micrometers and 50 micrometers sealed portions, and three types of 5 micrometers, 10 micrometers and 20 micrometers space portions. In addition, a transparent electrode 2-4 such as ITO is installed to be opposite to the upper and lower substrates. An alignment film 2-5 of polyimide is formed on the electrode. An aligning process has been performed on the alignment film 2-5 such that an angle of twist of liquid crystal 2-6 becomes an angle of ninety degrees by rubbing. Resin beads 2-7 for spacers for forming a gap of the two substrates are arranged. A diameter of the beads 2-7 is 4.5 micrometers and density thereof is 100number/mm^2. An acrylic ultraviolet curing type sealing material 2-8 for enclosing the liquid crystal 2-6 and adhering the substrates to each other is installed under the multilayer Cr.

[0024] Next, an evaluation result of the liquid crystal panel will be shown in 1. As items for evaluation, used are a width of abnormal alignment of a sealing material and a voltage maintaining ratio for showing voltage maintenance of liquid crystal when a 30Hz pulse wave is supplied to the liquid crystal at 5V.

[0025] First, as a conventional example 1, a heat curing type epoxy resin ("SUTORAKUTO bond XN-21-S" manufactured by the Mitsui Toatsu Chemicals industry) is used. In addition, as a compared example 1, the acrylic ultraviolet curing type sealing material is used. The substrate temperature is 25°C during the UV irradiation, the substrate temperature is 40°C for an embodiment 1, 60°C for an embodiment 2, and 80°C for an

embodiment 3. Results in this case are shown. In addition, the substrate is laid by setting a temperature of the hot plate to a target temperature. Accordingly, the substrate amounts to about five minutes at 40°C, about ten minutes at 60°C, and about fifteen minutes at 80°C. Here, the maintaining time of the predetermined temperature is sufficiently identical.

[0026] From these results, in the compared example 1, the width of the abnormal alignment of the sealing material exceeds 0.5mm, and a voltage maintaining ratio is about 90 %, which is low compared to the conventional example. Especially, in terms of the width of abnormal alignment of the sealing material, the active distance from the seal becomes short according to a liquid crystal construction. Even though this distance is the shortest, it is about 0.1mm. This is because a dummy pattern of a color filter is required and its width is required as wide as 0.1mm.

Accordingly, the width of the abnormal alignment of the sealing material is required less than 0.1mm. The maintaining ratio will be now described. Though there is a difference of an extent according to the construction of the liquid crystal panel, if a voltage maintaining ratio is less than 90%, it has a bad effect on a visual quality such as baking within a plane and a flicker. Accordingly, 90% or more voltage maintaining ratio is required. In addition, if it is 90% or more, no problem is generated with respect to non-uniformity of brightness within the plane.

[0027] At this time, in Figure 3, the result analyzed by Raman spectroscopy about a polymerization degree of the sealing material under the slit of the electrode to each temperature during the UV irradiation will be shown. In the method for calculating the polymerization precision by the Raman

spectroscopy, a difference between absorption of “C=C" bond part of a non-cured sealing material with absorption of "C=C" bond part of the sealing material when the temperature during the UV irradiation is 80°C and irradiation energy is 6,000mJ/cm^2 is expressed as 100, and an absorption rate of “C=C” bond part of the sealing material of each position is expressed as a percentage.

[0028] From this result, the shaded portions by the lines have a low polymerization degree as much as 20% in comparison to the space portions, but it does not depend on the distance. However, with respect to the temperature during the UV irradiation, though the polymerization degree of the sealing material at the space portion is lowered, a difference between the polymerization degree of the line shadings and space portions is not largely affected. On the basis of the evaluation of a seal panel as shown in Table 1, by the method for obtaining a polymerization degree by Raman spectroscopy, 60% or more polymerization degree does not generate a problem for use.

[0029] Next, Table 2 shows results of abnormal alignment of the sealing material and a voltage maintaining ratio when brightness of an ultraviolet lamp is 30mv/cm^2. Here, for the embodiment 3 and the embodiment 4, the substrate temperature 40°C and irradiation time is two hundred seconds. For an embodiment 5, the substrate temperature 40°C and irradiation time is six hundred seconds. For an embodiment 6, the substrate temperature 80°C and irradiation time is two hundred seconds. For an embodiment 7, the substrate temperature is 80°C and irradiation time is six hundred seconds. In addition, as a compared example 2, the substrate temperature is 25°C and irradiation

time is two hundred seconds. As a compared example 3, the substrate temperature 25°C and irradiation time is six hundred seconds. Here, when the irradiation time is two hundred seconds, irradiation energy is 6,000mJ/cm^2, and in case of six hundred seconds, the irradiation energy is 18,000mJ/cm^2.

[0030] From this result, when the substrate temperature is 40°C and irradiation time is two hundred seconds, there is no problem in a circumferential alignment state. However, when the substrate temperature is 25°C, if the irradiation time is lengthened, little effect can be obtained but does not satisfy quality. Accordingly, during the UV irradiation, the substrate temperature largely affects the curing of the sealing material.

[0031] In addition, when a liquid crystal panel is manufactured by the dropping method, a problem occurring when the substrate temperature increases during the UV irradiation is that a sealing material which has not sufficiently be cured comes in contact with high-temperature liquid crystal. Accordingly, when the substrate temperature increases and is left during the UV irradiation, a result with respect to an alignment state of a sealing material of a liquid crystal panel and a voltage maintaining ratio is shown in Figure 3. At this time, a condition for the UV irradiation is performed when the substrate temperature is 80°C, brightness of an ultraviolet lamp is 10mw/cm^2, and irradiation time is six hundred seconds. As an embodiment 8, leaving time before UV irradiation after adhering the substrates to each other is one minute at room temperature. As an embodiment 9, leaving time is two minute at room temperature. As an embodiment 10, the substrate temperature is 40°C and leaving time is two minute at room temperature. As

an embodiment 11, the substrate temperature is 60°C and leaving time is one minute at room temperature. As an embodiment 12, the substrate temperature is 80°C and leaving time is one minute at room temperature. As a compared example 4, the substrate temperature 100°C and leaving time is one minute. Since it actually takes about fifteen minutes for the substrate to increase the temperature from room temperature, one minute is long enough.

[0032] In Table 3, in the dropping method, the visual quality is not affected if the substrate temperature is up to 80°C during the UV irradiation. However, if the substrate temperature is 100°C, the width of abnormal alignment in the sealing material is bad as much as 0.5mm. This can be considered that a phase transition temperature of a liquid crystal material is 85°C, and the liquid crystal material becomes an isotropic phase, thereby increasing the solubility of the sealing material. Since a phase transition temperature in the actual liquid crystal material cannot fall below 80°C, there is no problem if the substrate temperature is up to 80°C in the dropping method and the sealing material can be sufficiently cured.

[0033] As so far described, a liquid crystal panel having a good visual quality can be provided even in a liquid crystal panel having line shadings of an electrode portion if the substrate temperature is 80°C, brightness is 10 to 30mw/cm^2 and irradiation energy exceeds 6,000 mJ/cm^2 as an ultraviolet condition for curing the sealing material.

[0034] As an ultraviolet type sealing material at the time, methacrylic and acrylic resin is used as a principal material, each photo-initiator of an acetophenone system, a benzoin system and a benzophenone system is compounded within the range of 1wt% to 3wt%, and a thioxanthone system

as photo-initiator is compounded within the range of 1wt% to 3wt%, and the filler material for viscosity control and the coupling agent of a silane system are compounded.

[0035] In addition, in the embodiments, though the line width of the electrodes is examined up to 50 micrometers, the electrode width which is 100 micrometers may be used on the basis of the result of the Raman spectroscopy. In addition, if the slit width exceeds 5 micrometers, there is no problem.

[0036]

[table 1]

(horizontal line) conventional example 1

compared example 1 embodiment 1embodiment 2 embodiment 3

(vertical line) width of abnormal alignment, voltage maintaining ratio

	従来例１	比較例１	実施例１	実施例２	実施例３
配向異常幅	＜0.1mm	＞0.5mm	＜0.1mm	＜0.1mm	＜0.1mm
電圧保持率	＞９５％	＞９０％	＞９５％	＞９５％	＞９５％

[0037]

[table 2]

	比較例２	比較例３	実施例３	実施例４	実施例５	実施例６	実施例７
配向異常幅	＞0.5mm	＞0.3mm	＜0.1mm	＜0.1mm	＜0.1mm	＜0.1mm	＜0.1mm
電圧保持率	＞９０％	＞９３％	＞９５％	＞９５％	＞９５％	＞９５％	＞９５％

[0038]

[table 3]

	比較例4	実施例8	実施例9	実施例10	実施例11	実施例12
配向異常幅	＞0.5mm	＞0.1mm	＜0.1mm	＜0.1mm	＜0.1mm	＜0.1mm
電圧保持率	＞85％	＞95％	＞95％	＞95％	＞96％	＞95％

[0039] [Effect of the invention] As described so far, the present invention relates to a method for manufacturing a liquid crystal panel by using an ultraviolet curing type sealing material which can improve bonding precision of substrates and productivity. A method for manufacturing a liquid crystal panel which can correspond to a color TFT liquid crystal panel whose edge portion is narrowed or a reflection type color STN panel.

[Description of Drawings]

[Fig. 1] is a schematic view illustrating a method for irradiating an ultraviolet ray in accordance with the present invention.

[Fig. 2] is a cross-sectional view of a liquid crystal panel used in the present embodiment.

[Fig. 3] is a graph illustrating a polymerization degree of a sealing material of an electrode shading portion in Raman spectroscopy.

[Explanation of Reference Numerals] 1-1 high-pressure mercury lamp, 1-2 glass for shielding a wavelength of 310nm or less, 1-3 shielding mask, 1-4 liquid crystal panel, 1-5 hot plate, 2-1 multilayer Cr slit substrate, 2-2 multilayer Cr slit, 2-3 substrate, 2-4 transparent electrode, 2-5 alignment layer, 2-6 liquid crystal, 2-7 resin beads, 208 acrylic ultraviolet curing type sealing material